

REMARKS

The following remarks are provided in response to the Office Action (“office action”) mailed September 26, 2007 in which the office action:

- required affirmation of Applicants’ provisional election with traverse to prosecute the invention of group 1, claims 1-22 and 24-32.
- objected to the declaration as being defective because non-initialed and/or non-dated alterations have been made to the oath or declaration.
- objected to the specification because of informalities.
- rejected claims 1-17 and 24-32 under 35 U.S.C. §102(e) as being anticipated by US Pub. 2002/0197884 to Niimi et al. (hereinafter Niimi).
- rejected claims 1-17 and 24-31 under 35 U.S.C. §102(e) as being anticipated by US Pub. 2004/0002226 to Burnham et al. (hereinafter Burnham).
- rejected claims 1-2, 4-7, 12-13, 15-17, 24-27 and 30 under 35 U.S.C. §102(b) as being anticipated by WO99/043023 to Benashel et al. (hereinafter Benashel).
(US 6,372,581 to Benashel et al. is used as a translation of WO99/043023 for the purposes of this rejection as it is a 35 USC 371 application of WO99/043023).
- rejected claims 1-9, 12-17, 24-28 and 31 under 35 U.S.C. §102(e) as being anticipated by US 6,372,578 to Muramatsu (hereinafter Muramatsu).
- rejected claims 10, 11, 29, 30 and 32 under 35 U.S.C. §103(a) as being unpatentable over Burnham or Benashel or Muramatsu in view of Niimi.
- rejected claims 18-23 under 35 U.S.C. §103(a) as being unpatentable over Niimi, Burnham, Benashel or Muramatsu in view of US Pub. 2002/0119674 to Thakur

(hereinafter Thakur).

The Applicants respectfully request reconsideration of the above referenced patent application for the following reasons:

Applicant's election

The office action required affirmation of Applicants' provisional election. Applicants hereby elect without traverse to prosecute the invention of group 1, claims 1-22 and 24-32. Applicants reserve the right pursuant to 35 U.S.C. §§ 120/121 to file a divisional application on the invention of originally filed claim 23.

Objection to the declaration

The office action objected to the declaration as being defective because non-initialed and/or non-dated alterations were made to the oath or declaration. The Applicants herein submit a Supplemental Declaration executed by inventor Gary Miner in compliance with 37 CFR §1.67(a) and respectfully request the objection to the declaration be removed.

Objection to the specification

The office action objected to the specification because of informalities. Specifically, line 1, paragraph [0038] reads "Figure 5" and should read "Figures 5A-5C." The Applicants herein amend paragraph [0038] of the specification according to the office action's suggestion and respectfully request the objection to the specification be

removed.

Claims 1-17 and 24-32 rejection under 35 U.S.C. §102(e)

Claims 1-17 and 24-32 are rejected under 35 U.S.C. §102(e) as being anticipated by Niimi. The Applicants herein cancel claims 2, 5, 13, 16 and 25 without prejudice. The Applicants herein amend independent claims 1, 8, 12 and 24, from which claims 3-4, 6-7, 9-11, 14-15, 17 and 26-32 depend, and respectfully request the Examiner to reconsider claims 1, 3-4, 6-12, 14-15, 17, 24 and 26-32 in view of the amendments and the following arguments.

Independent claim 1 has been amended to include the elements, *“incorporating nitrogen into a dielectric film using ammonia (NH₃) gas in a rapid thermal annealing process,” “wherein the nitrogen incorporated into the dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film.”* Independent claims 8, 12 and 24 have been amended to include similar elements. Thus, in claims 1, 3-4, 6-12, 14-15, 17, 24 and 26-32, the Applicants teach and claim a method of nitridation of a dielectric film with ammonia (NH₃) gas. The nitridation is carried out at an ultra-low pressure. Also, the nitrogen incorporated into the dielectric film forms **only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film.**

Niimi fails to disclose a method wherein the nitrogen incorporated into a

dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film. Niimi does disclose annealing an already plasma-nitridized film with ammonia to stabilize the nitrogen incorporated during the plasma-nitridation. (*See* Niimi, paragraphs [0034], [0052] and [0053].) However, the ammonia anneal of Niimi is carried out after the plasma-nitridation and is used to “create a uniform nitrogen distribution throughout the oxygen-containing layer” of nitrogen already incorporated in the oxygen-containing layer by the plasma-nitridation process. (*See* Niimi, paragraph [0009].) Thus, Niimi fails to disclose, and in fact teaches away from, a method wherein the nitrogen incorporated into a dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film, as taught and claimed by the Applicants.

Accordingly, the Applicants respectfully request the Examiner to withdraw the rejection to claims 1, 3-4, 6-12, 14-15, 17, 24 and 26-32.

Claims 1-17 and 24-31 rejection under 35 U.S.C. §102(e)

The office action rejected claims 1-17 and 24-31 under 35 U.S.C. §102(e) as being anticipated by Burnham. The Applicants herein cancel claims 2, 5, 13, 16 and 25 without prejudice. The Applicants herein amend independent claims 1, 8, 12 and 24, from which claims 3-4, 6-7, 9-11, 14-15, 17 and 26-31 depend, and respectfully request the Examiner to reconsider claims 1, 3-4, 6-12, 14-15, 17, 24 and 26-31 in view of the

amendments and the following arguments.

Burnham fails to disclose nitridation using ammonia (NH₃) gas. Burnham also fails to disclose a method wherein the nitrogen incorporated into a dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film. Burnham does disclose nitridation using plasma nitridation (*see* Abstract). However, plasma nitridation forms a nitrogen concentration peak at the top surface of the dielectric film and forms a “relatively uniformly distributed” tail to the bottom surface of the dielectric film. (*See* Burnham, paragraph [0033], Figure 10; *see also* Applicants’ specification, paragraph [0038]; Table 1.) Thus, Burnham fails to disclose both nitridation using ammonia (NH₃) gas and a nitridation method including forming only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film, as taught and claimed by the Applicants.

Accordingly, the Applicants respectfully request the Examiner to withdraw the rejection to claims 1, 3-4, 6-12, 14-15, 17, 24 and 26-31.

Claims 1-2, 4-7, 12-13, 15-17, 24-27 and 30 rejection under 35 U.S.C. §102(b)

The office action rejected claims 1-2, 4-7, 12-13, 15-17, 24-27 and 30 under 35 U.S.C. §102(b) as being anticipated by Benashel. The Applicants herein cancel claims 2, 5, 13, 16 and 25 without prejudice. The Applicants herein amend independent claims 1, 12 and 24, from which claims 4, 6-7, 15, 17, 26-27 and 30 depend, and respectfully

request the Examiner to reconsider claims 1, 4, 6-7, 12, 15, 17, 24, 26-27 and 30 in view of the amendments and the following arguments.

Benashel fails to disclose nitridation using ammonia (NH₃) gas. Benashel also fails to disclose a method wherein the nitrogen incorporated into a dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film. Benashel does disclose nitridation using NO gas (col. 2, line 44 and col. 3, lines 15-35). However, NO forms a nitrogen concentration peak at the bottom surface of the dielectric film. (See Applicants' specification, Table 1.) Thus, Benashel fails to disclose both nitridation using ammonia (NH₃) gas and a nitridation method including forming only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film, as taught and claimed by the Applicants.

Accordingly, the Applicants respectfully request the Examiner to withdraw the rejection to claims 1, 4, 6-7, 12, 15, 17, 24, 26-27 and 30.

Claims 1-9, 12-17, 24-28 and 31 rejection under 35 U.S.C. §102(e)

The Examiner rejected claims 1-9, 12-17, 24-28 and 31 under 35 U.S.C. §102(e) as being anticipated by Muramatsu. The Applicants herein cancel claims 2, 5, 13, 16 and 25 without prejudice. The Applicants herein amend independent claims 1, 8, 12 and 24, from which claims 3-4, 6-7, 9, 14-15, 17, 26-28 and 31 depend, and respectfully request the Examiner to reconsider claims 1, 3-4, 6-9, 12, 14-15, 17, 24, 26-28 and 31 in view of

the amendments and the following arguments.

Muramatsu fails to disclose nitridation using ammonia (NH₃) gas. Muramatsu also fails to disclose a method wherein the nitrogen incorporated into a dielectric film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film. Muramatsu does disclose a nitriding gas containing nitrogen oxide (col. 2, line 30 and col. 3, lines 41-42), wherein the nitrogen oxide can be NO, N₂O or NO₂ (col. 4, line 39). However, nitrogen oxide forms a nitrogen concentration peak at or close to the bottom surface of the dielectric film. (See Applicants' specification, Table 1.) Thus, Muramatsu fails to disclose both nitridation using ammonia (NH₃) gas and a nitridation method including forming only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of the dielectric film without forming a tail to the bottom surface of the dielectric film, as taught and claimed by the Applicants.

Accordingly, the Applicants respectfully request the Examiner to withdraw the rejection to claims 1, 3-4, 6-9, 12, 14-15, 17, 24, 26-28 and 31.

Claims 10, 11, 29, 30 and 32 rejection under 35 U.S.C. §103(a)

The Examiner rejected claims 10, 11, 29, 30 and 32 under 35 U.S.C. §103(a) as being unpatentable over Burnham or Benashel or Muramatsu in view of Niimi. The Applicants herein amend independent claims 8, and 24, from which claims 10, 11, 29, 30 and 32 depend, and respectfully request the Examiner to reconsider claims 10, 11, 29, 30

and 32 in view of the amendments and the above arguments.

Claims 18-23 rejection under 35 U.S.C. §103(a)

The Examiner rejected claims 18-23 under 35 U.S.C. §103(a) as being unpatentable over Niimi, Burnham, Benashel or Muramatsu in view of Thakur. The Applicants herein cancel claim 23 without prejudice. The Applicants herein amend independent claim 18, from which claims 19-22 depend, and respectfully request the Examiner to reconsider claims 18-22 in view of the amendments and the following arguments.

Independent claim 18 has been amended to include the elements, *“introducing ammonia (NH₃) gas” “for nitrogen to be incorporated into the silicon dioxide film,” “wherein the nitrogen incorporated into the silicon dioxide film forms only one nitrogen concentration peak, and wherein the nitrogen concentration peak occurs at the top surface of the silicon dioxide film without forming a tail to the bottom surface of the silicon dioxide film.”* Thus, in claims 18-22, the Applicants teach and claim a method of nitridation of a silicon dioxide film with ammonia (NH₃) gas. The nitridation is carried out at an ultra-low pressure. Also, the nitrogen incorporated into the silicon dioxide film forms **only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of the silicon dioxide film without forming a tail to the bottom surface of the silicon dioxide film.**

As described above, none of Niimi, Burnham, Benashel or Muramatsu, alone or in combination, disclose a nitridation method including forming only one nitrogen

concentration peak, wherein the nitrogen concentration peak occurs at the top surface of a silicon dioxide film without forming a tail to the bottom surface of the silicon dioxide film. The office action merely relies on Thakur to disclose “clustering various steps” in a cluster tool. (See office action, p. 12, section 9.) Accordingly, Thakur fails to cure the deficiencies of Niimi, Burnham, Benashel and Muramatsu. Thus, none of Niimi, Burnham, Benashel, Muramatsu or Thakur, alone or in combination, disclose a nitridation method including forming only one nitrogen concentration peak, wherein the nitrogen concentration peak occurs at the top surface of a silicon dioxide film without forming a tail to the bottom surface of the silicon dioxide film, as taught and claimed by the Applicants.

Accordingly, the Applicants respectfully request the Examiner to withdraw the rejection to claims 1, 3-4, 6-9, 12, 14-15, 17, 24, 26-28 and 31.

New Claims 33-42

New claims 33-37 depend from independent claims 1, 8, 12, 18 and 24, respectively. In view of the amendments to claims independent claims 1, 8, 12, 18 and 24 and in view of the above arguments, Applicants respectfully request consideration of new claims 33-37.

In new claims 38-42, Applicants teach and claim a method of forming a nitrogen-containing dielectric film. A dielectric film is formed on a substrate. Nitrogen is incorporated into the dielectric film using a rapid thermal annealing process with ammonia (NH₃) gas at an ultra-low pressure. The dielectric film does not comprise

nitrogen prior to the rapid thermal annealing process with ammonia (NH₃) gas. That is, in new claims 38-42, the Applicants teach and claim **incorporating nitrogen into a dielectric film using a rapid thermal annealing process with ammonia (NH₃) gas at an ultra-low pressure, wherein the dielectric film does not comprise nitrogen prior to the rapid thermal annealing process with ammonia (NH₃) gas.**

None of Niimi, Burnham, Benashel, Muramatsu or Thakur, alone or in combination, disclose a nitridation method including incorporating nitrogen into a dielectric film using a rapid thermal annealing process with ammonia (NH₃) gas at an ultra-low pressure, wherein the dielectric film does not comprise nitrogen prior to the rapid thermal annealing process with ammonia (NH₃) gas.

CONCLUSION

The Applicants submit that they have overcome the office action's objections to and rejections of the claims and that they have the right to claim the invention as set forth in the listed claims. The Examiner is respectfully requested to contact the undersigned by telephone if it is believed that such contact would further the examination of the present application.

Pursuant to 37 C.F.R. 1.136(a)(3), the Applicant(s) hereby request and authorize the U.S. Patent and Trademark Office to (1) treat any concurrent or future reply that requires a petition for extension of time as incorporating a petition for extension of time for the appropriate length of time and (2) charge all required fees, including extension of time fees and fees under 37 C.F.R. 1.16 and 1.17, to Deposit Account No. 02-2666.

Respectfully submitted,

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December 21, 2007

Date

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